

ON THE DIAGNOSIS OF ANEURYSM

OF THE THORACIC AORTA.

with especial reference to the application
of the X-rays.

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DEFINITION:

All writers are not agreed as to what actually constitutes aneurysm of the aorta. As generally understood, it signifies a local increase in the calibre of the vessel of various characters and degrees, while certain restrictions may be made to limit the range of its applicability. On the whole however, it is of little importance whether marked degrees of concentric dilatation be called aneurysm or not, for we have it in the authority of Clifford Albutt that dilatation of the aorta may give rise to pressure symptoms apart from the presence of aneurysm in the more restricted application of the term. For the purposes of this paper, the latter will be understood as including marked degrees of dilatation associated with more or less marked structural disease of the vessel, and capable of giving rise to local effects referable to the mere increase in size.

As to the nomenclature of the different varieties of aneurysm, the terms "true" and "false" have not for us precisely the same significance, nor do they imply such a contrast as with the older writers.

The purpose of this paper will be to present:-

Firstly:

A brief resumé of the history of the subject.

Secondly:

Some observations on the clinical features of thoracic aneurysms in so far as these bear upon the recognition of cases presenting some degree of difficulty or at least of uncertainty.

Thirdly:

The relation of a few original cases illustrated to some extent by photographic records.

HISTORICAL SKETCH:

The early history of the recognition of aneurysm belongs to the domain of Surgery rather than to that of medicine proper. External aneurysms were naturally recognised and investigated before the existence of similar conditions in the deeper parts of the body was even suspected, and the recognition of the latter may be said to have gradually developed out of the knowledge already obtained of the clinical and patho-

logical features of the former.

Galen is apparently the earliest author who wrote on aneurysm. He applies the term to the pulsating swelling resulting from a wound of an artery where the skin wound only has healed. He notes the features of pulsation and of disappearance on pressure and differentiates it from oedema. He seems to have also observed coagulation in the sac.

Aetius (De Vasorum Dilatatione - 6th Century) refers to the same condition, but also, like several other writers of this time, misapplies the term to other conditions especially bronchocele.

Paulus of Aegina separates true from false aneurysm. It is not, however, till we reach the 16th century that we find any reference to aneurysm of the great vessels, and Fernel was apparently the first to make mention of aortic aneurysm, which he states to be characterised by a violent throbbing. He dissents from the conception of aneurysm as necessarily originating in a rupture of the vessel, a view which, however, continued to find adherents considerably after his time.

It is, strangely, to an anatomist that the credit belongs of having first diagnosed aneurysm of the aorta during life. Vesalius was called from Belgium to Germany, as Albertini relates, to see a

nobleman who presented a large tumour in the back, near the vertebrae. This he pronounced to be an aneurysm and incurable, and his verdict was duly confirmed at the post-mortem examination two years later.

Ambroise Paré noted a blowing sound as audible over an aneurysm and described the appearance of calcification of the wall, and also the occurrence in large aneurysms of thrombus formation with disappearance of pulsation.

From Sennertus (1628) we have a description of the structure of an artery and his opinion that aneurysms arise by rupture of the internal and stretching of the external coats of the vessel, and that the former may result from causes acting from within. It was about this time that Harvey's great work on the circulation was published, and it is interesting to note that he made use of a case of aneurysm then under his observation to support his contention in regard to the movement of blood in the arteries. It was an aneurysm of the axillary artery with which was associated smallness of the pulse of the same side, the significance of which was correctly interpreted by the great physiologist.

In the writings of Wiseman, Surgeon to Charles II., we again enter the controversy on the pathology of

aneurysm. He also deals with the etiology of the condition and classifies the causes of aneurysm into external and internal.

Scant reference, however, to aneurysms of the deeper arteries is to be found in the various writers after Fernel till the early 18th Century is reached, when Lancisi wrote ably and at great length on the subject of aneurysms in general, including those of the aorta. Of the latter he relates several cases following injuries to the chest, in one of which, an aneurysm of the descending thoracic aorta which gave rise to a tumour in the back, he noted pulsation synchronous with that of the heart. This pulsation he further observed to diminish with the progress of the case, owing to "polypous" changes in the wall of the sac.

As an additional diagnostic sign he recognises irregularity in the movement of the portion of the artery distal to the dilatation. Lancisi made considerably advance on the work of his predecessors in regard to the more intimate pathological antecedents of aneurysm, for, while assigning to a separate class those following upon contusions, he states that in almost every case erosion must be considered as a concurrent cause. After a lengthy disquisition on the part played by altered blood states ("eroding

humours") in predisposing to aneurysm, he described the role of syphilis as a causative factor in some cases, a connection already recognised, however, by Severinus in the first half of the preceding century. The syphilitic variety, according to Lancisi, is to be differentiated from the traumatic by the more gradual appearance of pulsation, by the presence at an earlier period of painful conditions of bones and joints, and by the discovery of concurrent signs of syphilis in other parts of the body, as well as by the therapeutic test of retardation of the progress of the disease by the exhibition of specific remedies. The disappearance of pulsation in the larger aneurysms receives due notice from this writer, an occurrence already observed by Severinus and by Ruysch, who attributed it to the formation of coagula in the sac. Lancisi, however, while agreeing with Ruysch as to the influence of coagulation in bringing about this change, held that something more was required; namely a lessening of the vigour of the heart's action, which contention he supports by reference to the successful employment of venesection.

Amongst many extended and valuable observations, clinical and pathological, we find emphasis laid on the diminished calibre and irregularity of the artery distal to an aneurysm, while the various fallacies

attending this sign are not overlooked. To Lancisi we are thus indebted, not perhaps for many original observations, but certainly for much valuable matter relating to the physics and physiology of the circulation in general, and more particularly to the pathological and clinical problems attending the study of aneurysms.

With the progress of medical science during the 18th century we find, in regard to aneurysm, a deeper study of the minute anatomy and pathology of the vascular system in the work of such men as Monro of Edinburgh and William Hunter, and with this, fuller and more accurate observations on the clinical and pathological features of aneurysm of the aorta.

Amongst continental writers we have to notice two in particular - Haller and Albertini.

The names of Albertini and his friend Valsalva are inseparably bound up with the history of aneurysm especially from the therapeutic stand-point. Working together at the morbid anatomy of this affection, they found during their dissections that aneurysms of the aorta and great arteries were much more frequent than previously thought, and, as an outcome of their researches, conceived the plan of treating such cases by means of low diet and strict regimen, Valsalva himself being the first to employ the method

which formed the basis of the line of treatment which in our day is associated with the name of Tufnell.

Haller relates two cases of aneurysm of the aorta occurring in women with the pathological findings in each. In the first he describes in the interior of the aneurysm and throughout the whole course of the aorta the occurrence of ulceration and calcareous patches; the aortic cusps were indurated. In the second he found "a large quantity of grumous blood" of laminated appearance, also a "new accessory membrane" adherent to the wall of the vessel, greatly increasing its thickness and extending into the left carotid.

Of British writers of this period William Hunter calls for some notice. He describes at length a case of aneurysm of the arch of the aorta in a stay-maker whose occupation involved severe effort. No mention is made of syphilis as an antecedent. When seen by Hunter, a pulsating tumour was already visible to the right of the sternum, which sign, along with absence of pulsation in the left radial and temporal arteries, pain in the chest and back, dyspnoea and attacks of coughing, led Hunter, without difficulty, to the diagnosis of aneurysm. The case terminated, after gradual sloughing of the integuments over the tumour and repeated small bleedings, by rupture of the front wall of the sac and fatal haemorrhage.

Hunter made a careful dissection of the morbid parts and noted specially the presence of caries of the ribs and vertebrae, remarking in the case of the latter on the notable immunity of the intervertebral discs to the destructive process. Are there, he asks, any symptoms peculiar to aneurysm of the aorta before there is an external tumour with pulsation? He expresses the opinion that in such circumstances the diagnosis is only one of probability.

Monro (Donald 1760) describes several cases of aneurysm of the thoracic and abdominal aorta in two of which the condition was multiple. He comments on the obscurity in which the etiology of some of these cases is involved where no history of injury or venereal affection is obtainable and where the patient previously exhibited appearances of good health.

In regard to the recognition during life of aneurysm of the aorta, his conclusions are worthy of quotation. "We have", he says, "no pathognomonic signs by which we can know the true aneurysms when seated deep in any part of the body till such time as they become so large as to protrude outwards, for the symptoms attending them differ according to their situation, and are so similar to those produced by other diseases as to make it impossible for us to

distinguish them in the beginning. Perhaps a train of circumstances and symptoms, joined to the patients complaining of a strong pulsation in the part, may lead us to suspect what the case is, though we can never be certain till it can be felt or seen.

As far as the ordinary clinical diagnosis of aneurysm is concerned, Monro's dictum still holds true of a certain proportion of cases. Even after the reinforcement of clinical medicine by the physical methods associated with the names of Avenbruegger, Corvisart and Laennec, the latter had to admit that "in the present state of our knowledge there assuredly exists no certain means of ascertaining the existence of this disease until it shows itself externally". The last word as to the possibilities of auscultation in the detection of aneurysm was not, however, said by the author of the method, who indeed seems to have been unduly pessimistic on the subject. Bertin, in his treatise, points out, in regard to the cases in which Laennec failed to detect an aneurysm by this means, that properly applied, no such failure need have been recorded.

During the 19th century the publication of numerous cases of thoracic aneurysm, and the careful analysis by many observers of the various clinical signs and pathological associations, together with

deeper study of the pathology of the circulation in general, have gradually removed many of the difficulties which formerly assailed the clinician and have thus rendered errors of diagnosis less frequent. Nevertheless, the great lack of uniformity in the clinical features of the disease, their variation with the exact locality of the dilatation and, in a certain number of cases, the entire absence of any but the most equivocal signs still continue to render the ordinary clinical methods often insufficient to permit of a positive diagnosis.

In this, however, as in other fields, a way of escape from the imperfections of the senses has been afforded us by the discovery of Röntgen which has placed within our reach a weapon to reinforce our ordinary clinical armamentarium which, while in many cases yielding only interesting and more or less valuable confirmation, has proved itself capable of revealing what was till then unrecognised, or at most vaguely suspected.

THE X-RAYS IN DIAGNOSIS:

The application of this method to the detection of aneurysms within the thorax is little more than five years old. One of the earliest references is

to be found in the report of a case by MM. Béclère, Ondin and Barthelémy (Soc. Med. des Hôpitaux). The case was one of aneurysm at the junction of the arch and descending portion of the aorta, which had escaped detection by other means. According to these writers, the exact seat, form and dimensions could be determined and calcareous deposits in the wall of the vessel showed up in contrast with the normal or merely atheromatous parts. The autopsy confirmed the diagnosis.

The subject, however, did not come into prominence till the appearance of Walsham's paper read before the Röntgen Society in February 1900, and published in the Archives of that Society. He relates several cases in which the diagnosis of aneurysm was confirmed or made for the first time by this means. In one case previously diagnosed as bronchitis, an aneurysmal dilatation of the transverse portion of the arch was found; in two cases exhibiting the physical signs of aortic regurgitation, he found an aneurysmal dilatation of the first part of the arch. In one case the radiographic diagnosis was at fault, the skiagram suggesting pericardial effusion, whereas the post-mortem examination revealed a large aneurysm of the transverse arch.

Later in the same year, several other cases were reported by Walsham in the Lancet. One of these was the case of a man of 45 who had been seen by three consulting physicians and had been under treatment for intercostal neuralgia. The physical signs were obscure: there was a little tenderness on percussion over the upper dorsal vertebrae but no dulness, tracheal tug, pupillary signs or cough, and only slight dyspnoea. The screen, however, showed at once a large aneurysm of the aorta. In a further communication, published in the Edinburgh Medical Journal for April 1901, Walsham described in detail the application of the new diagnostic method and cited several cases in which the X-rays picture enabled a diagnosis of aneurysm to be made, amongst them being a case previously pronounced to be one of intrathoracic tumour. Meanwhile progress in the new diagnostic method was being made on the Continent, Mignon of Nice having originated a method of oblique penetration to the chest by which the recognition of aneurysms of the descending aorta might be facilitated.

The researches of Walsham left little of fundamental importance to be added to the subject, though improvement in X-ray technique and continued study of the radiosopic and radiographic appearances of

the chest in various morbid conditions have served to render its application more exact, to remedy earlier fallacies and to bring the recognition of the early stages of aneurysm of the aorta within the scope of clinical medicine.

THE CLINICAL DIAGNOSIS:

Most of the clinical and pathological associations of aortic aneurysm have been recognised for several decades, so that the modern clinical description of a case will present little advance upon those found in the works of Hope, Stokes and other writers of the earlier half of the 19th century.

Of the numerous symptoms and signs which have been recorded, only those will be noticed in this paper which call for comment in view of more recent observations of cases, individually or statistically, on which additional light has been thrown by modern research or which have at least appeared to have especial value in the experience of the writer.

GENERAL CONSIDERATIONS:

The recognition of aneurysm of the aorta may be easy or difficult according to circumstances. The clinical picture will vary according to the stage in which the case comes under observation. So equivocal are the earlier signs of this affection, that a patient suffering from, say, aortic incompetence or marked atheroma may remain for a considerable time under observation until signs of aneurysm develop under the eye of the observer or until some suggestion is productive of a more searching physical examination. At the best, the diagnosis, as Hunter says, may remain only one of probability and the patient pass from observation after, it may be, a restoration of compensation, with the doubt still unsolved. Should the case first present itself when some gross complication has supervened, the primary lesion may be much obscured, though the gravity of such an accident may of course render the recognition of the precise state of affairs a refinement of little value to the sufferer. Such are rupture into the vena cava and the supervention of acute tuberculosis of the lungs.

AGE AND SEX:

While aneurysm greatly predominates in the male sex and manifests itself most frequently in the 4th decade when, as Coats well expresses it, "the period of greatest bodily vigour overlaps the beginning of the period of occurrence of atheroma", it has been found at quite an early age.

Bontillier (Amer. Journ. of Med. Sci. May 1903) has collected 60 cases under 20 years of age, one of them in a girl of 9.

PREVIOUS HISTORY:

The various factors concerned in the production of atheroma may, one or more, be elicited by an enquiry into the history of the case, and, in virtue of this relationship, will point^{to} at least the possibility of aneurysm, but are of little or no value in the differentiation of this from mere degenerative cardio-vascular states. With regard to syphilis, there is some difference of opinion among authoritative writers as to its frequency as an antecedent. Without quoting statistics, it may fairly be said that syphilis has been found in the history of a sufficient percentage of cases to render a special enquiry of great importance in any more or less

obscure case of thoracic suffering, and a positive history of such strongly suggestive of the presence of aneurysm, while a denial of venereal infection on the other hand must leave the question entirely open. Of seven cases which I have investigated, three gave a history of syphilis. Laborious occupations or such as involve continued physical strain and consequent increase of blood pressure, inasmuch as they are recognised antecedents of atheroma, predispose to the development of aneurysm, but still more important is a history of more or less sudden strain of an exceptional degree, occurring in a person already presumably the subject of arterial degeneration. In one of my cases, such a combination of factors would seem to have been in operation: a man who had suffered from syphilis, while carrying a heavy steel rail, fell forwards down a slope and shortly afterwards developed symptoms of thoracic embarrassment. A similar history, however, is found in certain cases of aortic reflux where the sudden development, together with a peculiar quality of the bruit, suggest a rupture of one of the sigmoid valve segments. Indeed, the rapid appearance of symptoms after such an accident is a strong point in the differential diagnosis of the two conditions.

In the case just cited, where symptoms of aortic incompetence with a peculiar strident diastolic bruit accompanied other features pointing strongly to the presence of aneurysm, the immediate result of the accident would seem to have been valvular rather than arterial damage, though possibly both, the latter declaring itself necessarily at a later period than the former.

Direct violence applied to the chest has long been regarded as a possible exciting cause of aneurysms. Lancisi indeed classified aneurysms, including those of aorta, into those due to contrusions and those arising from intrinsic causes, while recognising cases in which the two factors co-operate. In one of my cases, a blow between the shoulders by a railway truck was followed after a short time by aching pain in that region and dyspnoea on exertion.

RELATIONS OF ANEURYSM WITH ARTERIAL DISEASE:

The type of arterial degeneration with which aneurysm is especially associated is undoubtedly atheroma. It is not always, however, that evidence of the existence of this condition is to be found by an examination of the peripheral arteries: a fairly soft radial vessel with little thickening of the wall may co-exist with well marked atheroma of the aorta

and this particularly at the comparatively early age upon which the incidence of aneurysm falls. This is practically tantamount to saying that the form of atheroma which usually paves the way for aneurysm is that due to syphilis, and some go so far as to hold that this syphilitic atheroma is a distinct variety probably related to the deep ulceration occasionally found in the larynx in the late secondary or secundo-tertiary stage of the disease. Martin expresses the opinion that in some instances at least the primary lesion is an obliterative endarteritis of the vasa vasorum, a view which is shared by Sansom, Bramwell and others. In this case the middle coat would suffer first and I have been shown sections which revealed a marked atrophy or even disappearance of the elastic laminae at quite an early stage.

But, leaving aside questions of intimate pathology, it is to be noted that the condition of the peripheral arteries cannot be depended on to give any valuable information qua the existence of aneurysm of the aorta, and indeed the presence of a marked degree of general arterial degeneration revealing itself in the radial and temporal arteries in the shape of rigidity and tortuosity, inasmuch as this is more likely to be found at a later period of life than that at which aneurysm is most common, is rather

against the probability of aneurysm, though it may be accompanied by a considerable degree of dilatation of the aorta.

In illustration of this, I may briefly cite a case recently under my observation. A man, 54 years of age, who denied syphilis, applied for treatment on account of palpitation, dyspnoea and precordial pain of a pricking character. Along with external evidences of marked general arterial degeneration, examination revealed an abnormal area of dulness above the heart, especially to the right of the sternum. This was so marked that the possibility of aneurysm was entertained, but there was no other sign suggestive of such a condition. He died of cerebral haemorrhage and the autopsy revealed a moderate degree of dilatation of the aorta, but no aneurysm. The aorta was only slightly affected with atheroma; but the peripheral and cerebral arteries markedly.

The case will be referred to again in connection with the radiographic appearances.

GENERAL ASPECT OF PATIENT:

Aneurysm should be suspected, writes Stokes, in cases where we find certain well-marked forms of

thoracic suffering to co-exist with an unimpaired state of the general health.

The general appearance of the patient will thus in the earlier stages, and perhaps even at a much later period, present nothing that is characteristic or even suggestive, in an uncomplicated case of aneurysm. When marked suffering has existed for a considerable time, it may of course reveal itself in a facial expression, indicative of distress or constant anxiousness, with often some degree of pallor, while the temporal arteries in many cases, though not in all, will by their rigidity and tortuosity, point to the presence of arterial disease. Even in cases attended with marked suffering, the attitude the patient assumes in bed is not constant, often he will be found in a sitting posture on account of dyspnoea, and the forcible action of the heart may be evidenced in a vibration communicated to the head with each heart-beat, but, on the other hand, in one of my cases where a large aneurysm was pressing upon and eroding the ribs and vertebrae, the man was comfortable only when lying on his back. Again the general aspect may be influenced by concomitant disease of the heart. Aneurysm not infrequently (in two out of seven cases of mine) co-exists with aortic regurgitation so that the clinical picture may be

that of the latter disease with its attendant pallor and general arterial throbbing. Or again the patient may present himself, as in another of my cases, with signs of failure of compensation and secondary mitral reflux which may for some time overshadow the presence of an aneurysm till the subsidence of these accidental features leave the further condition manifest or at least suspected.

SUBJECTIVE SYMPTOMS:

Of these pain is the most frequent. While it may be admitted that no variety of thoracic pain is with certainty to be interpreted as aneurysmal in origin, there are certain varieties, localities and distributions of pain which are especially frequent. Pain referred to the back of a persistent character should always excite suspicion of aneurysm of the arch or descending aorta. It is sometimes complained of between the shoulders, but perhaps more often in the left scapular region. It varies in intensity and in character in different cases, and in different stages of the disease from a dull aching, worse at right, to a more severe boring or gnawing sensation where erosion of the vertebrae is in process.

It is very liable to exacerbations during which it frequently radiates round the left chest to the axilla and breast and sometimes down the inner side of the arm as far as the hypothenar region. In one of my cases (III.) it was almost constant in the later months of the disease, though varying considerably in intensity from time to time; it was felt chiefly at the level of the 5th and 6th dorsal vertebrae, but when more severe, would extend round the left scapular region to the corresponding breast and sometimes down the left arm. Like the anginal attacks, which were a marked feature of the earlier stages of the case and which were probably of aortic origin, but which largely disappeared in the later stages to give place to the more persistent back pain, the exacerbations of back-pain were almost always nocturnal. Latterly they ~~were~~ ushered in attacks of paroxysmal dyspnoea of great severity. Fortunately the particular anatomical associations of the pain in this case are not yet demonstrable.

Associated with this variety of pain in some cases of aneurysm is a sign upon which perhaps sufficient stress has not been laid, namely that of :-

Spinal tenderness:

This no doubt does occur as part of a more widespread cutaneous hyperaesthesia in other morbid states of the thoracic organs, and particularly in

angina pectoris. In the latter, careful observations have been recorded, by Head and Gibson especially, of the distribution of superficial tenderness, from which it appears that a fairly large patch may be detected at a level corresponding to the lower cervical and upper dorsal vertebrae chiefly to the left of the spine, but sometimes even over to the right of it, and continuous with a band passing across the upper scapular region and down the left arm. In angina, however, while the tenderness may be elicited occasionally as low as the sixth dorsal spine, it is not likely to extend so far down as in some cases of aneurysm, nor generally to be so intense as in the latter. In one of my cases, while most marked at the mid-dorsal level, it increased in downward extent with the progress of the disease, being elicited latterly as low as the 8th dorsal spine. In contrast to this, I may cite a case where much thoracic suffering and pain of an anginous type accompanied signs of degenerative disease of the aortic valve, and which exhibited cutaneous hyperaesthesia about the left nipple, but where no tenderness was found over the spine. In another case of aortic disease with failure of compensation rather marked tenderness was present over the dorsal spines from the first to the seventh inclusive, which along with an abnormal area of dulness to the right of the

sternum, led to the detection by means of X-rays of an aneurysmal dilatation of the first part of the arch.

These signs are of course chiefly marked in aneurysms of the posterior part of the arch and of the descending aorta, but are none the less valuable from this restriction on account of the latest character sometimes displayed by aneurysm in this situation. Pain in the course of the nerves may be the only symptom till death occurs (Gowers).

A striking illustration of the importance of bearing in mind the possible significance of more or less obscure pain in this region is given by Watson (Princ. and Prac. of Med.). He relates a case where a man showed no other symptoms than pain in the back and a furred tongue; the latter disappeared under treatment, but the former remained. Some doubt was apparently entertained as to the genuineness of the complaint, in the absence of any discoverable cause, but the death of the patient confirmed the latter in his insistence by revealing an aneurysm pressing on the left side of the dorsal vertebrae.

Other forms of thoracic pain may attend the presence of aneurysm, but are less suggestive. True angina may be present as in one of my cases, but is probably to be attributed to associated lesions.

Precordial pain or oppression are found as in other cardiac disorders and are probably due to irritation of sensory filaments in the wall of the aorta. Pain somewhat localised in distribution may be present over the situation of the aneurysm, even when no prominence due to the latter is to be seen.

In a case (II.) of aneurysm of the arch situated towards the left, pain was complained of as shooting along a line from the episternal notch to the left nipple and in another, where dulness and pulsation were detected to the right, the chief pain was felt between the clavicle and the right margin of the sternum.

Pain obviously of a referred character was felt in the left upper axilla in two of my cases and was apt to persist during periods when back and breast pain were in abeyance.

Cutaneous hyperaesthesia over the precordia may be present but is of little value, being less common in aneurysm than in cardiac lesions.

In general the pain in aneurysm is liable to exacerbations from slight causes, exertion or excitement or even without obvious provocation, and is relieved by rest and by means which reduce arterial pressure. In one case even the act of mastication sufficed to excite pain in the breast and axilla in the absence of actual dysphagia.

DYSPNOEA:

Has long been recognised as a fairly frequent accompaniment of aneurysm and its various causes are well known. While in a marked case more or less constant, it is liable to aggravation by very slight exertion or by the occurrence of attacks of pain. Apart, however, from the dyspnoea which may attend the presence of aneurysm in virtue of its interference with the circulation or of its influence as a form of intrathoracic tumour, there is a special type of dyspnoea which, though not peculiar to aneurysm, is a striking feature of certain cases and stages of the disease. This is a paroxysmal dyspnoea, often of great severity, bearing a close resemblance to true asthma, and usually excited by exertion even of a slight degree. No special reference to this symptom is to be found in the older writers; it is fully described by Goodridge and by Newman (B. M. Journ. 1887). As regards the pathological associations of this symptom, there is probably no one determining cause, exacerbations of tracheal or bronchial compression and laryngeal spasm are variously put forward in explanation of the attacks, and each may be operative in individual cases, while the precise type of the dyspnoea will vary according to the seat of the temporary obstruction. Very severe attacks,

however, occur, as in one of my cases, where there are no other signs of tracheal or bronchial compression as laryngeal involvement, no Δ evidenced by stridor or deficient expansion of one lung, and where, as already stated, the dyspnoea bears a close resemblance to that of true asthma. In the case referred to, the attacks were usually ushered in and accompanied by pain in the back and breast, cyanosis of the face was followed later by pallor and the extremities were livid; there was orthopnoea with a marked expiratory element, attended later by troublesome cough and mucoid expectoration, sometimes slightly tinged with blood. The pulse during the attack was accelerated and small and the inequality and asynchronism of the radial pulses, previously well marked, was for the time being less distinct. It may be noted that nitrite of amyl, which in previous seizures of an anginal type gave prompt relief, was in these attacks without effect, whereas a hypodermic dose of morphia was soon followed by subsidence.

The mode of onset and the character of these attacks was such as strongly to suggest a nervous origin, a disturbance manifesting itself chiefly in the innervation of the intrapulmonary air-passages. I am not aware that sufficient minute post-mortem search has been made to connect such attacks with any one pathological cause, but it seems that irrit-

ation of vagal filaments may afford a possible explanation of a seizure that is almost certainly spasmodic.

The dyspnoea in cases of aneurysm, like other signs of the affection, is liable to remarkable fluctuations; repeated severe paroxysms may suggest an early termination of the case, and one may be surprised to find the attacks subside and the sufferer restored to a condition of comparative comfort. The onset of a period of dyspnoea may likewise occur with great rapidity, and de Haen records a case in which an external tumour projecting to the left of the sternum suddenly disappeared with an immediate increase of respiratory difficulty.

PHYSICAL SIGNS OF ANEURYSM:

These like the subjective symptoms may be in some cases entirely wanting. At the same time suggestive signs may be elicited by careful investigation which may be missed in the course of a routine examination of the heart and lungs.

THE INSPECTION OF THE PRECORDIA:

Should be carefully carried out under the best conditions as to illumination, the source of the light being if possible on the side opposite to the observer, and, if artificial, placed rather low so that shadows are thrown by the ribs and other prominence, while the eye looks along the surface of the chest from various points. By such means degrees of abnormal pulsation, otherwise liable to be overlooked, may be rendered evident. Inspection may reveal nothing abnormal, or only signs of accompanying cardiac enlargement where valvular lesion co-exists. The position of the apical impulse will depend largely on the state of the heart itself; I have frequently found it in the sixth interspace, but if the aortic orifice be competent, it may remain within normal limits. Walsham has noted that in some cases of aneurysm the heart assumes a more transverse position with outward displacement of the apex beat. A marked general precordial heave is visible in some cases, but more suggestive is a heaving of the upper part of the chest, and an aneurysm of the transverse portion of the arch may cause the sternum itself to rise slightly with each filling of the sac.

Abnormal pulsation especially to the right of the sternum above the 3rd rib, is generally due to

aneurysm of the aorta (Sansom). This may be present in both the second and the third spaces and may or may not be accompanied by the more diffused heave above mentioned. It is a sign of great importance, to be carefully looked for, even more so than that of percussion dulness in this situation which in my experience is to be found in moderate degrees of mere dilatation of the aorta. If carefully observed it may be found to be slightly behind the apical impulse in time, though if the heart be acting somewhat rapidly (Stokes suggests 70 per minute as the average limit) this feature may not be detected. In marked degrees an expansile character may of course be observed and various devices have been employed to demonstrate this. No pulsation may, however, be detected where percussion signs and, according to Walshe, even actual prominence suggest the presence of an aneurysm in the upper part of the chest, if coagulation have occurred in the sac.

In one of my cases, where a large aneurysm, involving the ascending aorta, innominate and greater part of the transverse arch was found after death, there was no abnormal pulsation whatever; a large pear-shaped laminated thrombus completely filled the innominate artery.

Enlargement of cutaneous veins over the upper part of the chest is frequently present in some degree, but is scarcely likely to help one in a difficult case. Slight degrees may be due to other and more general causes, though if found only or especially on one side, it should lead to a search for some explanation. Greater degrees if due to aneurysm will probably be accompanied by other and less uncertain signs, but, as Bramwell points out, are less frequent in aneurysm than in other forms of intrathoracic tumour.

PERCUSSION SIGNS:

Impairment of resonance to the right of the sternum above the 3rd rib is a sign of some importance and slight degrees are probably often overlooked. The significance of dulness in this situation depends, however, upon its extent, minor degrees being found in simple dilatation; I have been able to map out an appreciable area to the right of the sternum in aortic incompetence with atheroma and in atheroma alone. The use of a special plessimeter has been recommended for the more accurate determination of percussion changes in this region by Ewart and Sansom, and certainly yields a somewhat

larger area of dulness than the ordinary method, but in my experience the latter is little inferior to it and sufficient in the majority of cases. When, however, a distinct impairment of resonance can be traced outwards for two or more inches, and especially if a corresponding area of dulness be found to the left of the sternum at the same level, its significance is strongly in favour of aneurysm. Sansom states that it may be the only physical sign and certainly it was the means of leading me to suspect the presence of aneurysm in a case of aortic regurgitation with failure of compensation, a suspicion which was confirmed by X-ray illumination of the chest.

As regards the position and size of the cardiac dulness, it remains to be said that this will depend upon the co-existence or otherwise of disease of the heart itself, aortic incompetence being the most frequent lesion. Walsham's observation as to the occasional transverse position of the heart has already been noted and the sign is regarded by him as one of some diagnostic value. He cites a case (Lancet, May 9th 1903) of aortic regurgitation, in which the displacement of the apex was only outwards, which peculiarity led to further enquiry and to the discovery of an aneurysm. The size of the heart, says Walshe, in the absence of valvular disease may

not be increased, even from a very large sac of some years growth in the ascending aorta just above the valves.

The presence or absence of various shocks, thrills and sounds have been productive of much discussion, especially in the literature belonging to the earlier part of the last century, but they are of very uncertain value, depending, as they do, largely on accidental circumstances, particularly on the state of the aortic valve segments. If the latter be competent, valuable evidence may be yielded by a thudding character of the second sound and by a palpable diastolic shock which Walshe found to be better appreciated by bimanual palpation from front to back.

AUSCULTATORY SIGNS:

A systolic basal bruit is said to be uncommon in aneurysm, partly no doubt for the reason that degenerative changes in the aortic valve belong rather to a later period of life. Such a bruit, however, heard at some distance from the aortic area is more suggestive of aneurysm, though even then not conclusive. In one of the most marked of my cases, no systolic bruit was audible over the sac but a single

sound in no way differing from the first sound of the heart except that it was louder here than over the cardiac area, as was also the diastolic bruit which followed it. The "bellows murmur" of Laennec was, as early as 1834, shown by Stokes to be absent in the majority of cases and when present to be practically always of valvular origin.

As to auscultation of the back, a systolic bruit heard near the spine is suggestive of aneurysm by which it may be transmitted from the aortic orifice. In one case which presented a loud double bruit at the aortic area, this was well heard all along the dorsal spine, whereas in a case of simple atheromatous dilatation with loud basal systolic bruit, the latter was not heard posteriorly or only very faintly though the accentuated second sound was well heard as low as the last dorsal vertebra. On the whole, however, I should be inclined to place most reliance on an intensification of the sounds or bruits conducted from the base of the heart, over a rather large area to the right or left of the upper sternum, or in some other unusual situation.

EXAMINATIONS OF THE NECK:

The different varieties of arterial pulsation in the neck may occasionally present points of dif-

difficulty as to their significance. Episternal pulsation where this is accompanied by a distinct impulse may be due to dilatation of the arch or to an abnormal origin of the right carotid artery and in a case where aneurysm is a possibility, the differentiation may be somewhat difficult unless the outline of the latter vessel is distinctly felt and its continuity with the upper part of the artery made out. In a case under my observation where a woman presented marked pulsation above the inner end of the right clavicle and in the episternal notch, along with slight inequality of the pupils and radial pulses, the point was very difficult to decide. Aneurysm of the innominate or arch of the aorta was suspected, but, in the absence of other signs and of positive results with radiography, the diagnosis remains in question.

Disparity of size and degree of pulsation in the carotid and subclavian arteries of the two sides may be observed, but moderate degrees of inequality, especially in the subclavian pulses, may be of doubtful origin. Dilatation of one subclavian artery of a temporary character has been described apart from aneurysm, and is probably of neurovascular origin; and again, where some alteration of calibre is present, it may be found on one side at one time

and on the other at a subsequent examination.

Of the tracheal tug first pointed out by Oliver as a sign of aneurysm of the transverse arch, it has to be noted that like other signs it is liable to variation and may be present on one examination and absent or doubtful at another. It is, however, a sign of first importance and practically pathognomonic of aneurysm in this situation.

EXAMINATION OF THE BACK:

This should never be omitted. Cutaneous hyperaesthesia and particularly pain on pressure over the dorsal spines has already been dealt with.

Careful percussion (and here I have found the plessimeter of some value) may elicit an area of dulness to the side of the spine. In one case, presenting signs of an aneurysm extending over to the right of the sternum, I found a small area of impaired resonance to the right of the spine at the level of the 4th - 6th dorsal vertebrae; in another case a larger area to the left at a lower level, where other signs pointed to aneurysm towards the left side.

SPINAL RIGIDITY:

When an aneurysm has come to press upon and erode the vertebral bodies, we have a state of affairs presenting little practical difference from the local effects of tuberculous disease and though I have found no reference in the literature to rigidity of the spine as an accompaniment of an aneurysm erosion, it seems quite probable that such may be exhibited, just as in the more common variety of caries. In one of my cases (II.), it was noted that the dorsal part of the spinal column was kept rigid when the patient stooped to pick up an object and it was rather remarkable that at the same time no tenderness was elicited over this part of the spine. It may be observed in passing as an interesting point in connection with the influence of posture on the pain and suffering attending aneurysms, that in this case the patient experienced least discomfort when lying on his back.

THE RADIAL PULSE:

Of the general characters of the pulse, it may be said in brief that they depend on two factors chiefly:-

- (a) The presence or absence of general arterial degeneration, and
- (b) The presence or absence of aortic incompetences.

As previously suggested, where the peripheral arteries yield evidence of marked general arterial degeneration, the probability of the existence of aneurysm is not great.

DISPARITY OF THE PULSES:

Even Laeunec was aware of the uncertainty of this sign. Inequality of the radial pulses may be found in health and in a variety of morbid states. Watson mentions its occurrence in a girl as a result of compression of the subclavian by an exostosis of the first rib, but more important is the fact that such inequality may exist with atheroma in the absence of aneurysm, depending doubtless on the distribution of the degenerative process.

Differences of tension in the two arteries is perhaps less uncertain, though it had been found by Oliver in cases of lead colic.

By careful digital examination of the pulses in two cases of aneurysm, I ascertained the following features:-

- (a) A slow rise and fall of pressure in one radial lacking the abruptness of the normal pulse wave.
- (b) Along with this, a greater compressibility of the pulse on that side.
- (c) An inequality in respect of the time of arrival not of the pulse wave so much as of the summit of the pressure curve. This latter character was best appreciated by a fairly firm application of the examining finger.

With regard to the value of the pulse evidence in determining the locality of an aneurysm, it has to be borne in mind as a source of fallacy that the artery of the corresponding side may be actually the larger of the two. This peculiarity I have noted in one case, but as to whether, as Sansom suggests, it depends on vasomotor paralysis, I am unable to express an opinion; there was no change in the corresponding pupil.

Of the various pressure effects of aneurysm, including vocal and paralysis and other still rarer signs, I shall refer only to those exhibited by:-

The Pupils:

Pupillary inequality is even more uncertain than the signs yielded by the radial pulse. It is frequently met with, apart from local disease, in health and in other affections, such as chlorosis. In a case where the possibility of aneurysm was en-

tertaind, it was evidently due to old iritis; but on the other hand, inasmuch as iritis may have a syphilitic origin, such a condition may be indirectly helpful as an indication of antecedent specific disease.

THE X RAY FEATURES OF ANEURYSM:

Of the two chief methods of examination, radioscopy and radiography, the former is the more important as the presence or absence of pulsation is thus noted.

Radioscopy:

The patient should, if possible, stand with the chest exposed and the arms raised above the head while the tube is raised to the required height and brought within a few inches of the body. The view should be made from both aspects, the patient presenting alternately the front and the back to the screen, and the picture is usually clearer in the latter position. With the screen in position, the heart shadow now becomes visible, and is rendered more distinct by the descent of the liver and diaphragm if a deep inspiration be taken and the breath held.

The size, position and movement of the heart are noted.

Above the heart shadow and tapering upwards towards the manubrium is that thrown by the aorta which normally projects only a short distance to each side of the shadow due to the sternum and vertebrae. The breadth of the aortic shadow, disease apart, will vary with the type of chest under examination so that familiarity with the normal radiosopic picture in chests of various shapes and sizes is necessary to a correct interpretation. If such allowance be made, a fairly marked enlargement of the aortic shadow may be taken to indicate at least some degree of dilatation; a very large shadow, particularly if this increases in breadth when followed upwards or shows a distinct bulging to right or left, is almost certainly due to aneurysm, and if this shadow shows distinct pulsation the evidence is conclusive.

Pulsation may, however, be fairly well marked in simple dilatation, so that some care is necessary, while on the other hand, as in one of my cases, a large aneurysm may show absolutely no pulsation on the screen or at the most an indefinite flicker at the edge of the shadow. Only the occurrence of coagulation in the sac could produce this effect which may afford a means of estimating the progress

of a case towards recovery. In one of my cases well marked pulsation was visible, but when screened two years later was extremely slight.

RADIOGRAPHIC METHOD:

This, though less important than the former, is useful for purposes of comparison.

A fairly rapid plate is to be preferred of 12 x 15 size and may be placed either beneath the patient or upon the chest and steadied there during the exposure. The patient should, if possible, be fully recumbent, and a clearer photograph is usually to be had from behind, the plate, enclosed in a light-tight paper bag, being placed beneath the chest. To render the upper part of the picture as clear as possible, the arms are raised above the head.

The length of exposure varies with the type of chest, the efficiency of the apparatus, and the quality of the plate and its distance from the tube, as in X-ray exposures in general, from 10 seconds to two minutes. Walsham gives a minute and a half as the average exposure in the case of a thin adult.

APPEARANCE IN NORMAL CHEST:

The heart shadow is fairly clearly defined. Below it the liver and diaphragm throw a more or less blurred outline owing to the respiratory movements. Above the heart the aortic shadow is seen with varying distinctness in different cases, according to the shape and other characters of the chest. Its size is probably always somewhat exaggerated owing to its distance from the tube. At the upper and left part of the shadow a curious rounded prominence is seen which at first somewhat puzzled the radiographer, but was soon recognised to be caused by the backward curve of the aortic arch. It is visible on most plates, but is more or less marked according to the obliquity of the tube to this part of the chest.

IN ANEURYSM:

In aneurysm and marked degrees of dilatation, an exaggerated aortic shadow is seen and in the former is variously altered in shape according to the position of the tumour.

The heart shadow may be normal or, as described by Walsham, may occupy a more transverse position than normally.

The density of the shadow:

In some cases the aneurysmal shadow is denser than that of the heart, namely in those where coagulum is present, this substance being less penetrable than the fluid blood which is practically transparent to the rays.

For a similar reason the density of the aneurysmal shadow may vary in different parts, while denser areas have been found to coincide with the position of calcareous plaques in the vessel.

The above remarks have reference chiefly to aneurysms of the ascending aorta and arch, those of the descending aorta are more difficult to detect, being blended with the heart shadow. M. Mignon of Nice has devised a method by which aneurysms occupying the posterior mediastinum may be more readily detected. By this so-called lateral-oblique method of illumination, the author states that a good view of the anterior and posterior mediastina may be obtained. A local bulging of the vertebral shadow into the "retrocardiac" clear zone might be due to aneurysm or to oesophageal tumour, more likely the former.

The differentiation of aneurysms from other intrathoracic conditions capable of throwing a visible shadow is to be made by noting the relation of

such shadow to that of the heart and aorta; if due to an aneurysm, it will be continuous with the latter and definitely related to it.

It remains to be observed, in conclusion, that the X-rays, besides affording valuable and often conclusive evidence as to the presence, situation, size and even contents of an aneurysm, may also yield information as to changes which occur in the tumour in the course of the disease.

ORIGINAL CASES.Case I. Aortic Incompetence and Aneurysm.

W.M., 52. Hide Sorter.

History:

No syphilis. Arduous occupation. Pain in left scapular region and shortness of breath for a year.

Clinical Features: Failure of compensation.

Pulse - no inequality, moderate thickening.

Heart - physical signs of aortic incompetence with secondary mitral reflex. Double bruit at all areas, maximal in 2nd right space, but heard over unusually large area to right of sternum. Harsh systolic in neck.

Additional Signs:

1. Abnormal area of dulness above 3rd right rib, reaching $2\frac{1}{2}$ inches from middle line.
2. Visible pulsation in 2nd right space.
3. Tenderness outside left nipple and to right of sternum.
4. Tenderness over dorsal spines, 1st to 7th.

X-Ray Examination:

Very large clearly defined shadow above heart well over to right with definite pulsation.

Radiogram (No.2):

Great enlargement of aortic shadow, especially to right, with distinct bulge. On the left side the usual knob-like projection due to the curve of the arch is well seen.

Subsequent History:

Re-admitted in 6 weeks with return of dropsy, etc. Signs of aneurysm now more marked. Larger area of dulness and pulsation to right of sternum with distinct heaving and slightly expansile impulse in upper sternal region. Feeble 1st sound and diastole bruit over heart but more audible to right of sternum. No systolic bruit. No enlargement of veins over chest.

Pulse - right radial smaller excursion and delayed.

Back - Tenderness over dorsal vertebrae from 3rd to 9th, and over a fairly large area on each side. Impaired resonance to right of 4th to 6th.

Case II., in which signs suggested tumour.

P.P. 31. Seaman.

History:

Syphilis Blow between shoulders a year before.

Complaint:

Aching pain at left scapula for 12 months, dyspnoea on exertion; latterly pain in left breast passing round to back.

Physical Signs:

No enlargement of heart. Dulness over manubrium and to left with expansile heave and pulsation in 2nd right and 3rd left spaces. Enlarged veins over left chest. Systolic bruit at aortic area, vessels of neck and between scapulae. 2nd sound accentuated, but not thudding, better heard below left clavicle. Pupils and pulses equal. No tracheal tug.

Radioscopic Examination:

Screen on chest - rounded, ill-defined and indistinct shadow above heart, no pulsation. Heart shadow normal.

Screen on back - abnormal shadow seen well and distinctly chiefly to left of spine, left edge rounded

and even, no pulsation.

Shadow is in position of and looks like aneurysm of descending arch.

Radiogram No.3.

Course of Case:

Left pupil became larger than right but variable. Some rigidity of dorsal spine unattended by tenderness on pressure. Pulses remained equal.

Some amelioration of symptoms took place, pain lessened and was almost confined to axilla; area of dulness and prominence of veins also diminished.

Screened several times, but no pulsation ever seen, so that probable diagnosis of growth was made, though admitted that it might be an aneurysm in which coagulation had taken place. Three months after admission seen by surgeon who suggested sarcoma. Lived 8 months after this and latterly suffered much pain in back and side of chest, especially in sitting posture.

Termination: Rupture into left pleura.

Autopsy:

Sacculated aneurysm of descending arch involving slightly the transverse arch and descending aorta,

full of laminated clot. Advanced atheroma with calcification and ulceration. Rupture occurred through atheromatous ulcer.

Marked erosion of 4th, 5th and 6th vertebrae, and 3rd to 7th ribs adjoining.

Heart not enlarged, aortic orifice dilated, but valve competent.

Case III. Aortic Incompetence and Aneurysm.

T. W. 40. Labourer.

History:

Syphilis in 3rd decade.

Fell forward while carrying load 4 years ago, which was almost immediately followed by noise in ears and later by bruit audible to patient. Increasing dyspnoea with pain over heart and down arms for three years.

Clinical Features:

Pain: precordial and down arms. Nocturnal anginous attacks. Pain in left scapular region, and occasional aching pain over front of upper arms.

Dyspnoea: Moderate degree, but liable to exacerbations. Buzzing sound in left ear.

Pulse: Water hammer, no special thickening.

Heart: Aortic regurgitation, with peculiar groaning quality of diastolic bruit, suggestive of rupture of valve segment. Double murmur at all areas, harsh systolic in neck.

Back: Tenderness over upper dorsal spines, especially 3rd. Double murmur along spine as far as 1st or 2nd lumbar.

Course of Case:

Three months after admission some dyspnoea was

complained of and slight tracheal tug noted. Dulness was detected to right of upper sternum.

Radioscopic Examination:

Marked pulsation over heart shadow but no bulging to right or left. The heart shadow was very dense suggesting possibility of aneurysm of descending aorta. Diagnosis therefore still uncertain.

Later some inequality of radial pulses was noted. Anginal attacks became less frequent and pain took the form of more persistent backache, referred mainly to the level of the 5th and 6th dorsal vertebrae. Spinal tenderness became more marked and was present as low as the 9th. Referred pain was experienced along the course of the intercostal nerves and sometimes down the inner side of the arm and forearm.

About 10 months after admission paroxysmal dyspnoea appeared on slight exertion or during the night. Dulness in the upper cardiac area was now observed to extend more to the left than to the right of the sternum and diminished percussion resonance was detected to the left of the spine at the mid-dorsal level.

Again Screened:

Large and markedly pulsating shadow above the heart, extending well over to the left side.

The case is still under observation; exacerbations of pain and dyspnoea are frequent, requiring morphia for their relief; tracheal tugging is only doubtfully present.

The condition of the patient did not permit of a successful radiograph.

Case IV. "Cured" Aneurysm.

J.D. 42. Engine Driver.

Complaint:

Pain in 1st right intercostal space, for four weeks.

Clinical Features:

Tenderness, expansile pulsation and impaired percussion note over inner parts of 2nd and 3rd interspaces and adjoining part of sternum.

Systolic bruit on pressure with stethoscope over this area. Second sound of heart heard much more plainly here than at base of heart. Sounds over heart faint but clear. Smallness of right radial pulse. Pupils equal.

Skiagram:

Large aneurysm of the arch bulging into the left chest.

Clinical Course:

Lessening of pain and pulsation under treatment. The patient presented himself again 6 months later and was pronounced clinically as cured. The photograph shown (No.4) is from a plate taken at this time. The negative was an indifferent one, but the aneurysm is seen as a large rounded and well-defined shadow encroaching on the right chest.

Case V. Illustrating the disappearance of pulsation
as seen by the screen.

This was a case of Dr Thurston Holland's, published by him in the Liverpool Medico-Chirurgical Journal for March 1901. The chest, however, was again screened by Dr Holland in October 1902 - two years after the exposure of the plate reproduced in that publication - and he has kindly supplied me with the results of this later examination, the interesting nature of which is the explanation of my including the case in this series.

Case - J.B. 45.

History:

Oppression in chest from four months ago, followed by some shortness of breath and hoarseness.

Clinical Features:

Pupils equal; carotid pulses equal; smallness of left radial pulse, paralysis of left vocal cord. Slight increase of dulness over and to the left of the sternum in the 2nd and 3rd spaces.

Screen Examination:

Rounded pulsating tumour bulging well over to the left above the heart, slight extension of shadow

to right of sternum. Apex of heart slightly displaced downwards.

Course of Case:

Six weeks after the left radial pulse was almost imperceptible. No other change in the physical signs had taken place, but dyspnoea and hoarseness were less marked.

Two years after the first examination the chest was again screened. No marked alteration in the size of the shadow was found, but pulsation was practically absent, clotting having thus occurred in the sac.

Case VI.

The remaining skiagram (5) is from a case of simple dilatation with atheroma.

Clinically there was some dulness in the upper cardiac area and some tenderness outside the left nipple, but no pain or other signs of aneurysm.

With the screen pulsation of the enlarged aortic shadow was visible.

The patient died of cerebral haemorrhage, there was dilatation of the aorta and a moderate degree of atheroma, but no aneurysm.

LIST OF APPENDED PHOTOGRAPHS.

All the radiographs are taken from the back so that the sides are reversed.

- I. Radiograph of normal chest.
- II. Aneurysmal dilatation of the ascending aorta, Case I.
- III. Aneurysm of descending portion of arch (Case II.)
- IV. Aneurysm of first part of arch (Case IV.)
- V. Simple atheromatous dilatation, (Case VI.)
- VI. Patient presenting external tumour due to due to aneurysm.

Note: Appearance of premature age, enlargement of temporal arteries, and anxious expression.

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